2003 SPRING LAKE TROUT ASSESSMENT

METHODS

Thirty stations were sampled in the Apostle Islands (WI-2) (Figure 1) with the R/V *Hack Noyes*. Each site was sampled with 2,700 ft of multifilament nylon gill net with 4-1/2-in stretch mesh. Nets were set for one night (24 hr) at each station.

Sixteen stations were sampled in western Wisconsin waters (WI-1) (Figure 1) with the R/V *Hack Noyes*. Each site was sampled with 900 ft of multifilament nylon gill net with 4-1/2-in stretch mesh. Nets were set for one night (24 hr) at each station.

All live fish were measured (total length), tagged, checked for sea lamprey marks and fin-clips, and then released. Dead fish were processed in the same manner except stomach contents were collected and frozen, individual weights were taken when lake conditions permitted, scale samples were taken, and otoliths removed from natives longer than 23.0 in.

Fish ages were estimated using scales and otoliths. Mean length-at-age was estimated by combining spring lake trout data from 2000, 2002, and 2003 because age was estimated for a low number of fish in each year.

Mean weight-at-age and length-weight equations were estimated by combining spring lake trout data from 2000, 2002, and 2003. Condition was evaluated using relative weights, estimated from accepted length-weight parameters for lake trout in Lake Superior (Piccolo et al. 1993). A relative weight of 100 indicated the fish was at its expected weight.

Following the protocol established by the Lake Superior Technical Committee, diet was analyzed by examination of stomach contents. Frequency of occurrence, percent composition by number, and percent composition by weight of food items were calculated from the stomach contents.

RESULTS/DISCUSSION

SEA LAMPREY WOUNDING

Wounding data were collected annually to monitor the effectiveness of control programs and follow trends. Sea lamprey wounding has been consistently lower in WI-2 than WI-1 (Table 1 and 2).

CATCH-PER-UNIT-OF-EFFORT (CPUE)

In 2003, 452 lake trout were sampled within WI-2. Native fish accounted for 91.6% of the

sample. Mean length of native lake trout was 24.0 in (11.9-36.8)(Figure 2). Geometric mean CPUE of native fish decreased from 21.5/1000 m in 2002 to 12.4/1000 m in 2003 (Figure 3, Table 3). Mean length of hatchery-reared lake trout was 23.7 in (7.6-36.2)(Figure 2). Geometric mean CPUE of hatchery fish decreased from 3.4/1000 m in 2002 to 0.99/1000 m in 2003 (Figure 3, Table 3).

In 2003, 161 lake trout were sampled within WI-1. Native lake trout abundance has been gradually increasing and now accounts for 29.8% of the catch. Mean length of native fish was 22.9 in (18.8-33.4)(Figure 4). Geometric mean CPUE of native fish decreased from 2.6/1000 m in 2002 to 1.2/1000 m in 2003 (Figure 5, Table 4). Mean length of hatchery-reared lake trout was 25.3 in (9.5-35.8)(Figure 4). Geometric mean CPUE of hatchery fish decreased from 3.7/1000 m in 2002 to 2.2/1000 m in 2003 (Figure 5, Table 4).

Geometric mean CPUE of lake trout in WI-1 and WI-2 decreased in 2003. Although hatchery fish have been decreasing gradually, the decrease in native fish CPUE was inconsistent with recent trends. The drop in CPUE may have been more a function of sampling condition than decrease in lake trout abundance. Persistent ice in WI-2, for example, caused sampling to be delayed which may have affected catch rates.

GROWTH and CONDITION

Mean age of lake trout captured in WI-1 was 8.1 (4-17) for native fish and 7.4 (2-21) for hatchery fish from 2000 through 2003 (Table 5). Mean age of lake trout captured in WI-2 was 8.7 (3-31) for native fish and 7.2 (2-18) for hatchery fish (Table 5). Mean length-at-age for native and stocked lake trout was similar in WI-1 and WI-2.

Mean weight of lake trout captured in WI-1 was 1581 g (439-3746) for native fish and 1601.9 g (104-5269) for hatchery fish from 2000 through 2003. Mean length-at-age for native and hatchery lake trout captured in WI-1 and WI-2 are found in Table 6.

Length-weight (mm/g)) equations for lake trout in WI-1 were:

Native -> Log (W) = -5.000 + 2.975*Log (L)
Hatchery -> Log (W) = -5.534 + 3.175*Log (L)

Length-weight (mm/g) equations for lake trout in WI-2 were:

Native -> Log (W) = -4.786 + 2.903*Log (L)
Hatchery -> Log (W) = -5.449 + 3.139*Log (L)

The intercept and slopes from the length-weight equations for native fish in WI-1 and WI-2 indicated slower growth compared to the Lake Superior growth parameters in Piccolo (1993) (-6.558 and 3.568). Those parameters, however, may have been developed using both native and hatchery lake trout which would inflate the weight-at-ages. Furthermore, lake trout weights may fluctuate with prey abundance cycles. Length-weight equations developed during a period of greater prey abundance may cause unusually good growth conditions.

Relative weights (condition) were lower than expected (<100) for lake trout in WI-1 and WI-2 (Figure 6 and 7). Relative weights are calculated using expected weights developed from standard length-weight parameters. Similar to the length-weight equations, the parameters used came from Piccolo (1993) and may have caused unrealistic expected weights, thus lower relative weights. Therefore, lower relative weights were not a cause for immediate concern but if condition were depressed over an extended time period further investigation may be needed.

DIET ANALYSIS

In 2003, the stomach contents of 160 (26 were empty) lake trout from WI-1 and WI-2 were examined. *Mysis relicta* constituted the largest percentage of lake trout diet by number, but rainbow smelt were present in more stomachs and constituted more of the lake trout's diet by weight (Table 7).

REHABILITATION PROGRESS

Native lake trout abundance continues to increase within WI-2 and WI-1. Lake trout stocking is no longer necessary in WI-2 and the 1994 year class was the last to be stocked. This is a sign of continued progress in lake trout rehabilitation. Maintenance of the refuges in combination with sport and commercial regulations, and sea lamprey control, are needed for rehabilitation to continue. Lake trout will continue to be stocked in WI-1 until the stocking protocol established by the Lake Superior Technical Committee indicates otherwise.

SISCOWETS

Siscowet (fat) lake trout were caught during the spring lean lake trout assessment (Table 8 and 9). Abundance has increased over the years, but sampling does not occur in siscowet habitat, consequently trends may only be marginal indicators of abundance.

Table 1. Sea lamprey wounds per 100 lake trout from spring assessment 4-1/2 inch nylon gill nets (sample size) in WI-1, 1987-2003.

Year	< 17"	17-20"	21-24"	25-28"	29"->	Total
1987	0.0 - (6)	8.7 - (208)	18.8 - (335)	31.4 - (105)	66.7 - (9)	18.1 - (663)
1988	0.0 - (5)	7.5 - (40)	11.6 - (241)	22.2 - (117)	0.0 - (10)	13.8 - (413)
1989	0.0 - (4)	3.2 - (62)	12.4 - (209)	16.4 - (152)	31.6 - (19)	13.2 - (446)
1990	0.0 - (14)	2.8 - (144)	16.1 - (112)	28.6 - (98)	33.3 - (15)	14.4 - (383)
1991	0.0 - (11)	6.7 - (102)	15.0 - (140)	19.8 - (86)	11.1 - (9)	13.2 - (348)
1992	0.0 - (5)	6.3 - (64)	17.9 - (95)	34.0 - (47)	16.7 - (12)	17.5 - (223)
1993	0.0 - (22)	0.0 - (98)	14.4 - (187)	23.0 - (148)	29.2 - (41)	14.7 - (496)
1994	0.0 - (32)	0.0 - (59)	13.0 - (54)	5.8 - (52)	0.0 - (16)	4.7 - (213)
1995	0.0 - (6)	1.0 - (101)	6.3 - (126)	14.1 - (85)	14.8 - (27)	7.2 - (345)
1996	No Sampling					
1997	0.0 – (39)	0.0 – (71)	7.8 – (115)	11.6 – (86)	26.7 – (30)	7.9 – (341)
1998	0.0 - (32)	1.4 - (69)	2.9 - (69)	7.3 - (55)	41.2 - (17)	5.8 - (242)
1999	0.0 – (25)	0.0 – (116)	1.1 – (181)	2.4 – (41)	15.8 – (19)	1.6 – (382)
2000	9.1 – (11)	1.5 – (65)	5.3 – (169)	16.7 – (36)	100 – (16)	11.1 – (297)
2001	No Sampling					
2002	0.0 – (6)	2.1 – (48)	1.3 – (159)	19.3 – (109)	38.3 – (47)	11.4 – (369)
2003	0.0 – (4)	0.0 – (21)	4.5 – (66)	4.3 – (47)	21.7 – (23)	6.2 – (161)

Table 2. Sea lamprey wounds per 100 lake trout from spring assessment 4-1/2 inch nylon gill nets (sample size) in WI-2, 1985-2003.

Year	< 17"	17-20"	21-24"	25-28"	29"->	Total
1985	1.9 - (52)	3.2 - (318)	6.7 - (556)	7.9 - (241)	12.5 - (32)	6.0 - (1,199)
1986	1.7 - (58)	1.3 (550)	6.7 - (935)	10.3 - (377)	11.9 - (42)	5.9 - (1,962)
1987	0.0 - (42)	2.5 - (600)	6.2 - (753)	14.9 - (262)	21.1 - (38)	6.4 - (1,695)
1988	2.9 - (34)	1.1 - (357)	8.4 - (464)	13.8 - (246)	20.4 - (54)	7.7 - (1,155)
1989	0.0 - (23)	2.3 - (478)	7.0 - (742)	11.3 - (432)	16.0 - (50)	7.0 - (1,725)
1990	0.0 - (35)	1.9 - (471)	3.7 - (484)	10.6 - (339)	8.3 - (84)	5.0 - (1,413)
1991	1.7 - (58)	1.8 - (391)	4.5 - (584)	6.7 - (374)	11.3 - (106)	4.7 - (1,513)
1992	0.0 - (45)	1.6 - (316)	9.2 - (601)	12.4 - (315)	23.0 - (74)	8.6 - (1,351)
1993	0.0 - (59)	1.0 - (302)	5.6 - (393)	6.0 - (318)	10.5 - (105)	4.7 - (1,177)
1994	0.0 - (58)	0.9 - (230)	1.2 - (485)	3.0 - (370)	8.2 - (98)	2.2 - (1,241)
1995	0.0 - (30)	0.7 - (426)	1.9 - (643)	7.2 - (375)	8.7 - (127)	3.3 - (1,601)
1996	No Sampling					
1997	0.0 – (90)	0.3 – (356)	2.1 – (533)	4.9 (347)	5.1 – (158)	2.5 – (1,484)
1998	0.0 - (46)	0.6 - (357)	0.9 - (462)	4.8 - (147)	8.6 - (93)	1.9 - (1,105)
1999	0.0 – (37)	0.8 – (479)	1.0 – (707)	2.9 – (138)	10.1 – (99)	1.7 – (1460)
2000	0.0 – (33)	0.9 – (437)	4.3 – (1036)	15.4 – (247)	31.8 – (107)	6.5 – (1860)
2001	No Sampling					
2002	0.0 – (17)	0.0 – (166)	3.3 – (398)	7.4 – (203)	23.4 – (64)	5.1 – (848)
2003	0.0 - (8)	0.0 - (62)	2.5 - (244)	5.1 - (98)	12.5 - (40)	3.5 - (452)

Table 3. Catch data for spring sampled lake trout in 4-1/2-in nylon gill nets from WI-2, 1981-2003. Nets were set for three nights from 1981-2000 and for one night beginning in 2002.

Year	Effort (Feet)	Sample Size	Native Sample Size	Native Geometric Mean CPUE	Native Mean Size (in)	% Native	Hatchery Geometric Mean CPUE
1981	63,300	763	227	5.1	23.9	29.9	11.1
1982	90,000	814	250	2.6	23.5	30.7	5.6
1983	17,400	139	43	2.5	24.1	30.9	5.5
1984	18,000	208	62	2.9	23.7	29.8	9.0
1985	78,300	1,303	459	3.5	23.2	35.2	6.9
1986	88,200	2,093	1,039	8.1	22.7	49.7	8.9
1987	83,700	1,730	1,047	7.0	22.2	60.5	6.9
1988	83,700	1,166	628	6.2	23.1	53.9	5.4
1989	83,700	1,728	954	8.9	23.6	55.2	6.6
1990	83,700	1,395	883	7.4	23.6	63.3	4.5
1991	83,700	1,487	1,031	8.5	23.5	69.3	4.9
1992	83,700	1,351	967	8.5	23.6	71.6	3.7
1993	83,700	1,176	893	9.5	24.0	75.9	3.4
1994	83,700	1,241	967	10.2	24.0	77.9	3.3
1995	83,700	1,601	1,132	12.1	23.8	70.7	3.4
1996				No Sampling			
1997	83,700	1,484	1,032	11.2	24.4	69.5	4.0
1998	83,700	1,105	775	8.0	23.2	70.1	3.0
1999	83,700	1460	926	11.2	22.9	63.4	4.8
2000	83,700	1860	1233	14.9	23.3	66.3	5.7
2001				No Sampling			
2002	83,700	848	719	21.5	23.7	84.8	3.4
2003	81,000	452	414	12.4	24.0	91.6	0.9

Table 4. Catch data for spring sampled lake trout in 4-1/2-in nylon gill nets from WI-1, 1987-2003. Nets were set for three nights from 1987-2000 and for one night beginning in 2002.

Year	Effort (Feet)	Sample Size	Native Sample Size	Native Geometric Mean CPUE	Native Mean Size (in)	% Native	Hatchery Geometric Mean CPUE
1987	17,100	665	85	0.8	20.7	12.8	3.0
1988	17,100	415	35	0.5	23.0	8.4	2.2
1989	17,100	449	29	0.3	21.7	6.5	2.0
1990	17,100	384	52	0.6	20.5	13.5	1.9
1991	17,100	348	68	0.8	22.0	19.5	2.0
1992	17,100	223	68	0.7	21.3	30.5	1.6
1993	17,100	496	103	1.1	21.6	20.8	2.7
1994	17,100	213	62	0.8	21.6	29.1	1.5
1995	17,100	345	146	1.4	22.3	43.2	2.1
1996	No Sampling						
1997	17,100	341	137	1.4	23.2	40.2	2.1
1998	17,100	242	90	1.0	23.1	37.2	1.6
1999	17,100	382	101	1.1	22.7	26.4	2.5
2000	17,100	297	109	1.5	22.3	36.7	2.4
2001	No Sampling						
2002	14,400	369	125	2.6	23.9	33.9	3.7
2003	14,400	161	48	1.2	22.9	29.8	2.2

Table 5. Length-at-age of native and stocked lake trout from 4-1/2-in nylon gill nets from WI-2 and WI-1, 2000-2003.

WI-2 - Apostle Islands

NATIVE																					
Age	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	31
Number	3	18	78	136	126	90	57	40	25	20	9	2	5	2	2	2	1	2	1	1	2	1
Mean Length (in)	11.7	16.4	19.5	21.1	22.2	23.5	24.2	25.6	24.7	26.1	26.7	29.9	26.7	30.2	30.0	28.0	32.1	32.0	30.5	30.2	32.8	35.8
STOCKED																					
Age	2	3	4	5	6	7	8	9	12	13	17	18									
Number	1	1	3	13	63	169	37	13	13	1	1	1									
Mean Length (in)	9.2	11.9	18.3	18.0	19.6	21.9	21.4	22.3	24.5	24.5	21.7	33.3									

WI-1 - Western Waters

NATIVES														
Age	4	5	6	7	8	9	10	11	12	13	14	16	17	
Number	1	4	14	19	18	4	6	3	1	3	1	1	1	
Mean Length (in)	14.5	17.0	19.8	21.3	23.0	23.8	24.9	25.0	25.0	26.4	24.2	28.6	26.9	
STOCKED														
Age	2	3	4	5	6	7	8	9	10	11	12	14	17	21
Number	1	2	4	16	24	32	31	6	4	2	3	4	1	1
Mean Length (in)	11.5	10.7	16.5	19.2	21.1	22.8	23.1	24.3	24.5	22.7	25.9	28.5	32.5	33.9

Table 6. Mean weight-at-age (g) for lake trout captured in WI-1 and WI-2 from 2000-2003.

	WI-1				WI-2			
Age	Sample Size	Native	Sample Size	Hatchery	Sample Size	Native	Sample Size	Hatchery
2	-	-	1	182	-	-	-	-
3	-	-	2	154	-	-	1	240
4	1	439	4	805	1	116	1	908
5	4	727	13	1135	5	608	5	854
6	12	1131	23	1393	37	1032	29	1150
7	16	1388	30	1732	39	1326	68	1633
8	14	1705	27	1699	40	1539	16	1427
9	3	1723	4	1965	27	1797	6	1546
10	4	1907	-	-	22	1949	-	-
11	3	2396	2	1563	12	2147	-	-
12	1	2736	3	2739	6	2216	5	2298
13	3	3197	-	-	4	2396	-	-
14	1	1728	2	3292	1	2629	-	-
15	-	-	-	-	1	4504	-	-
17	1	2554	1	5269	-	-	-	-
22	-	-	-	-	1	5249	-	-

Table 7. Diet composition of lake trout captured from WI-1 and WI-2 in 2003 (percent frequency of occurrence (%FO), items found (IF), percent composition by number (%CN), total item weight (g) (IW), and percent composition by weight (%CW)).

	Natives						Hatchery					
No. examined	98						62					
No. empty (%)	12 (12.2)						14 (22.5)					
Food Item	Occurrence	%FO	IF	%CN	IW (g)	%CW	Occurrence	%FO	IF	%CN	IW (g)	%CW
Herring	3	3.1	5	0.3	252.0	10.0	0	0.0	0	0.0	0.0	0.0
Coregonus Sp.	5	5.1	5	0.3	57.8	2.3	2	3.2	2	0.2	51.1	2.0
Rainbow Smelt	46	46.9	330	18.5	1553.5	61.4	27	43.5	209	25.5	1876.0	74.6
Burbot	2	2.0	3	0.2	123.0	4.9	0	0.0	0	0.0	0.0	0.0
Sculpins	2	2.0	3	0.2	6.0	0.2	1	1.6	1	0.1	4.0	0.2
Sticklebacks	18	18.4	64	3.6	88.9	3.5	2	3.2	11	1.3	12.2	0.5
Unidentified Fish	34	34.7	132	7.4	430.1	17.0	28	45.2	66	8.0	559.2	22.2
Mysis relicta	5	5.1	1199	67.1	15.9	0.6	2	3.2	528	64.3	6.8	0.3
Aphipods	3	3.1	14	0.8	0.0	0.0	1	1.6	1	0.1	0.0	0.0
Terrestrial Insects	2	2.0	11	0.6	0.5	0.0	1	1.6	1	0.1	3.1	0.1
Other	5	5.1	21	1.2	1.6	0.1	2	3.2	2	0.2	1.0	0.0
Total			1787		2529.3				821		2513.4	

Table 8. Catch data of siscowet lake trout from WI-2, 1981-2003. Nets were set for three nights from 1981-2000 and for one night beginning in 2002.

Year	Effort (ft)	Sample Size	Fish/1000 ft	CPUE > 25”	Mean Length (in)
1981	63,300	1	0.16	0.16	25.2
1982	90,000	0	--	--	--
1983	17,400	7	0.4	--	20.3
1984	18,000	20	1.1	0.14	20.5
1985	78,300	0	--	--	--
1986	88,200	1	0.01	--	22.4
1987	83,700	9	0.11	--	21.5
1988	83,700	7	0.084	--	20.5
1989	83,700	17	0.2	--	21.5
1990	83,700	9	0.11	0.036	24.2
1991	83,700	29	0.5	0.036	21.9
1992	83,700	22	0.26	0.024	22.1
1993	83,700	40	0.48	0.036	21.7
1994	83,700	42	0.5	0.012	21.1
1995	83,700	30	0.36	0.06	22.3
1996			No Sampling		
1997	83,700	30	0.36	0.13	22.5
1998	83,700	45	0.18	0.18	23.4
1999	83,700	41	0.5	0.07	21.4
2000	83,700	70	0.84	0.18	22.5
2001			No Sampling		
2002	83,700	21	0.3	--	22.7
2003	81,000	24	0.3	0.05	22.7

Table 9. Catch data of siscowet lake trout from WI-1, 1987-2003. Nets were set for three nights from 1987-2000 and for one night beginning in 2003.

Year	Effort (feet)	Sample Size	Fish/1000 ft	CPUE > 25”	Mean Length (in)
1987	17,100	1	0.06	--	17.6
1988	17,100	1	0.06	--	20.0
1989	17,100	0	--	--	--
1990	17,100	2	0.12	0.06	22.9
1991	17,100	6	0.35	0.06	20.6
1992	17,100	1	0.06	0.06	27.8
1993	17,100	16	0.94	--	--
1994	17,100	1	0.06	--	--
1995	17,100	1	0.06	--	20.7
1996			No Sampling		
1997	17,100	8	0.47	0.23	25.5
1998	17,100	31	1.8	0.82	22.8
1999	17,100	14	0.82	0.11	20.8
2000	17,100	6	0.35	0.12	23.2
2001			No Sampling		
2002	14,400	1	0.1	--	17.5
2003	14,400	8	0.55	0.35	26.2

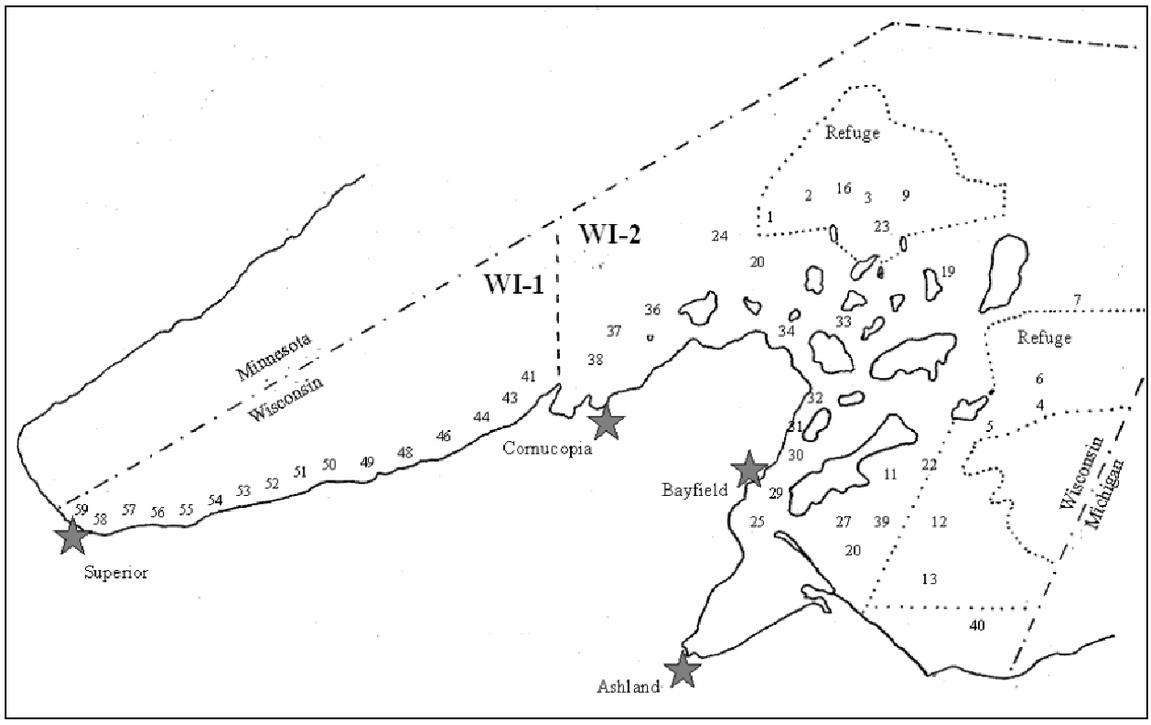

Figure 1. Gill net sites for spring lake trout assessment in the Wisconsin waters of Lake Superior, 2003. Wisconsin waters are divided into two management regions, WI-1 and WI-2.

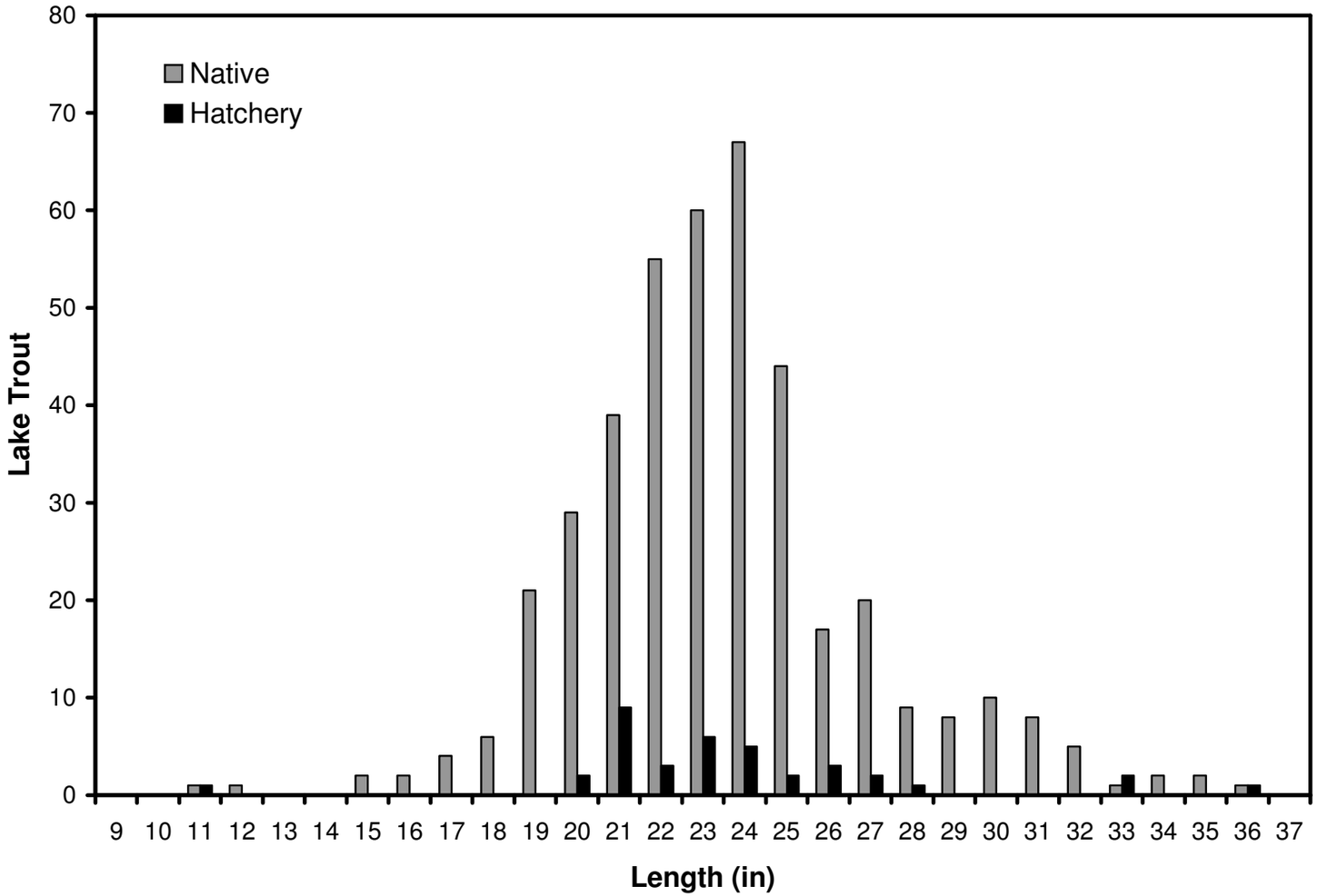

Figure 2. Length frequency of native and hatchery-reared lake trout caught in WI-2, 2003.

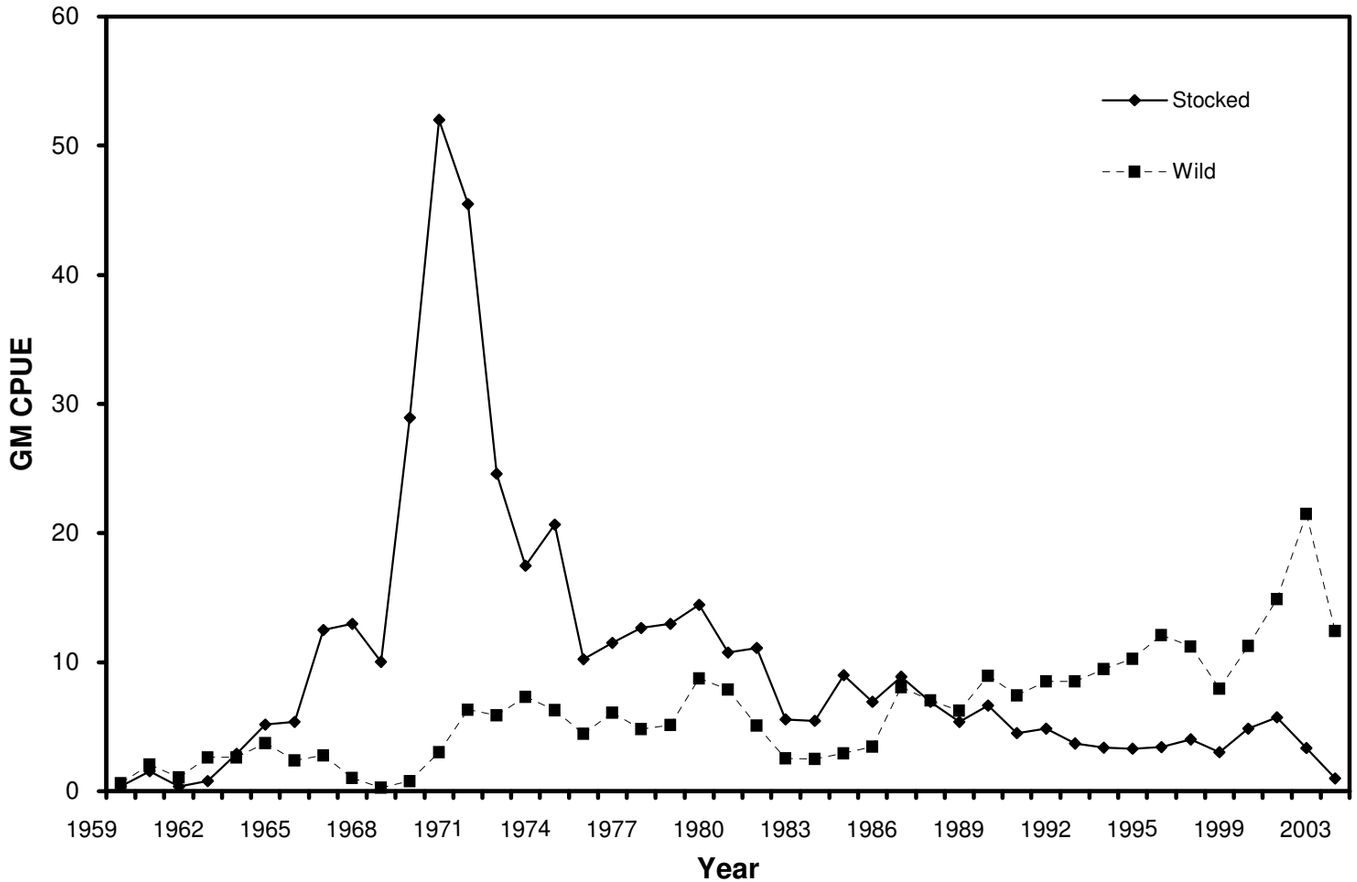

Figure 3. Geometric mean catch-per-unit-effort (GM CPUE) of native and hatchery-reared lake trout in WI-2, 1959-2003. Lake trout were not sampled in 1996 and 2001.

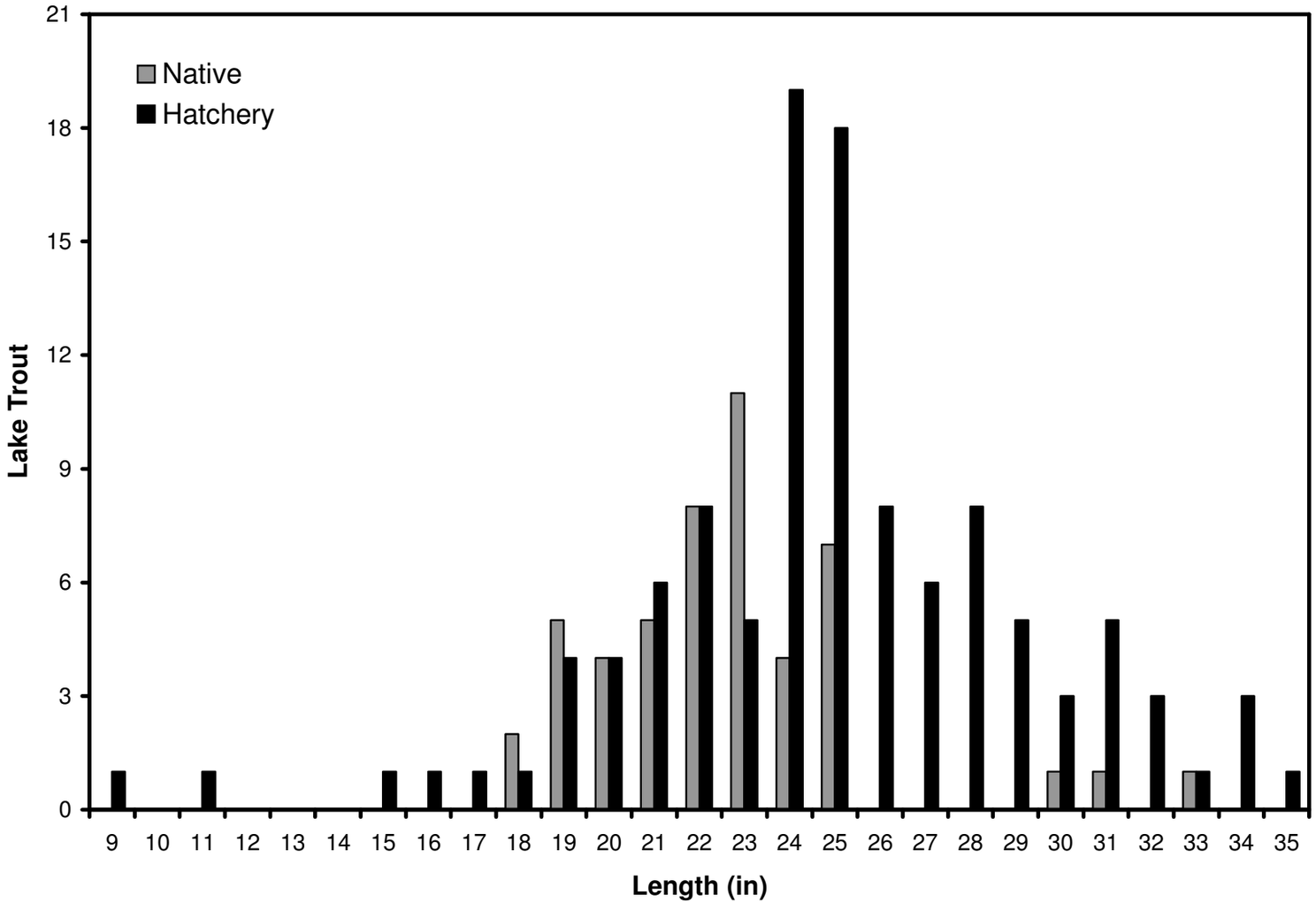

Figure 4. Length frequency of native and hatchery-reared lake trout caught in WI-1, 2003.

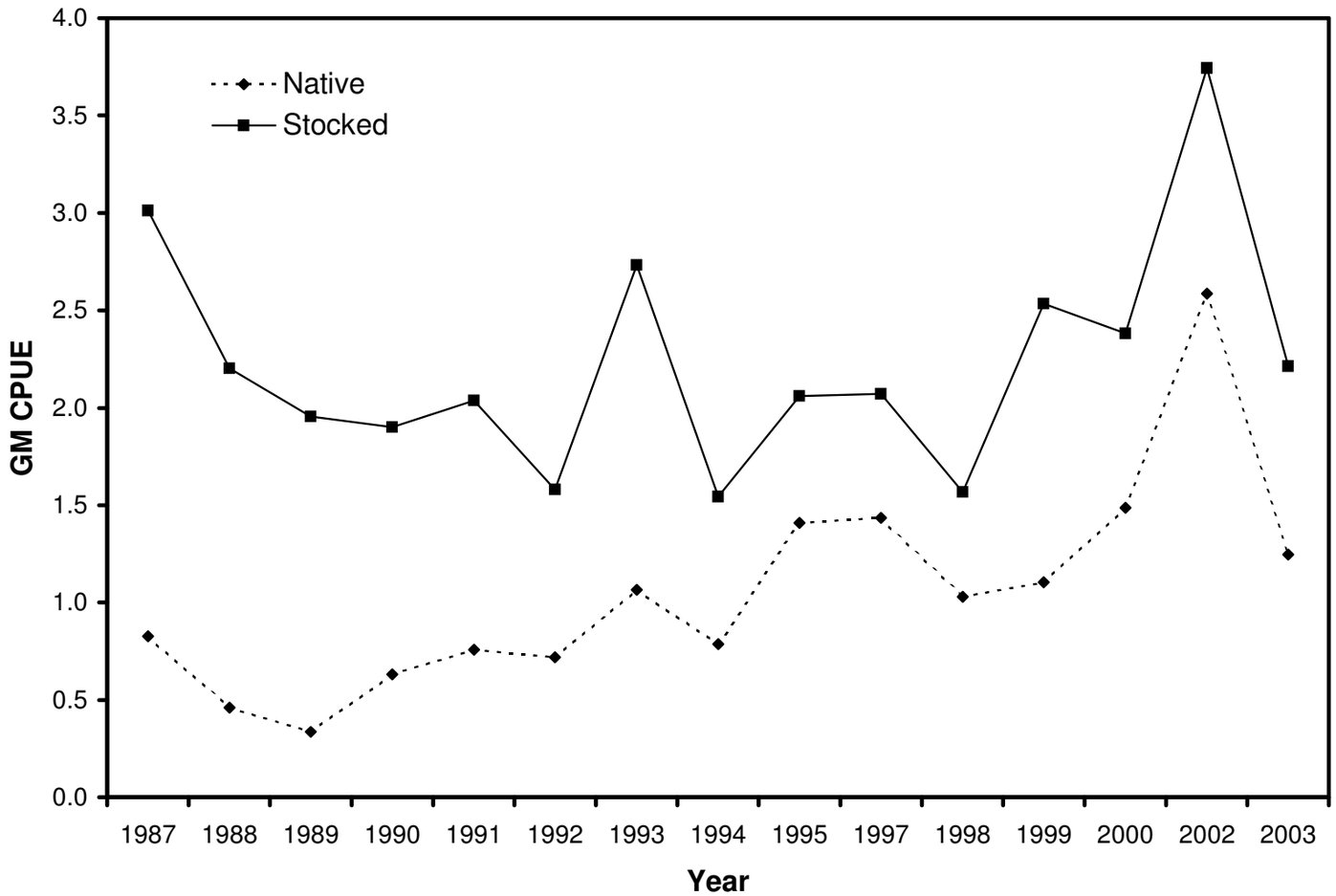

Figure 5. Geometric mean catch-per-unit-effort (GM CPUE) of native and hatchery-reared lake trout in WI-1, 1987-2003. Lake trout were not sampled in 1996 and 2001.

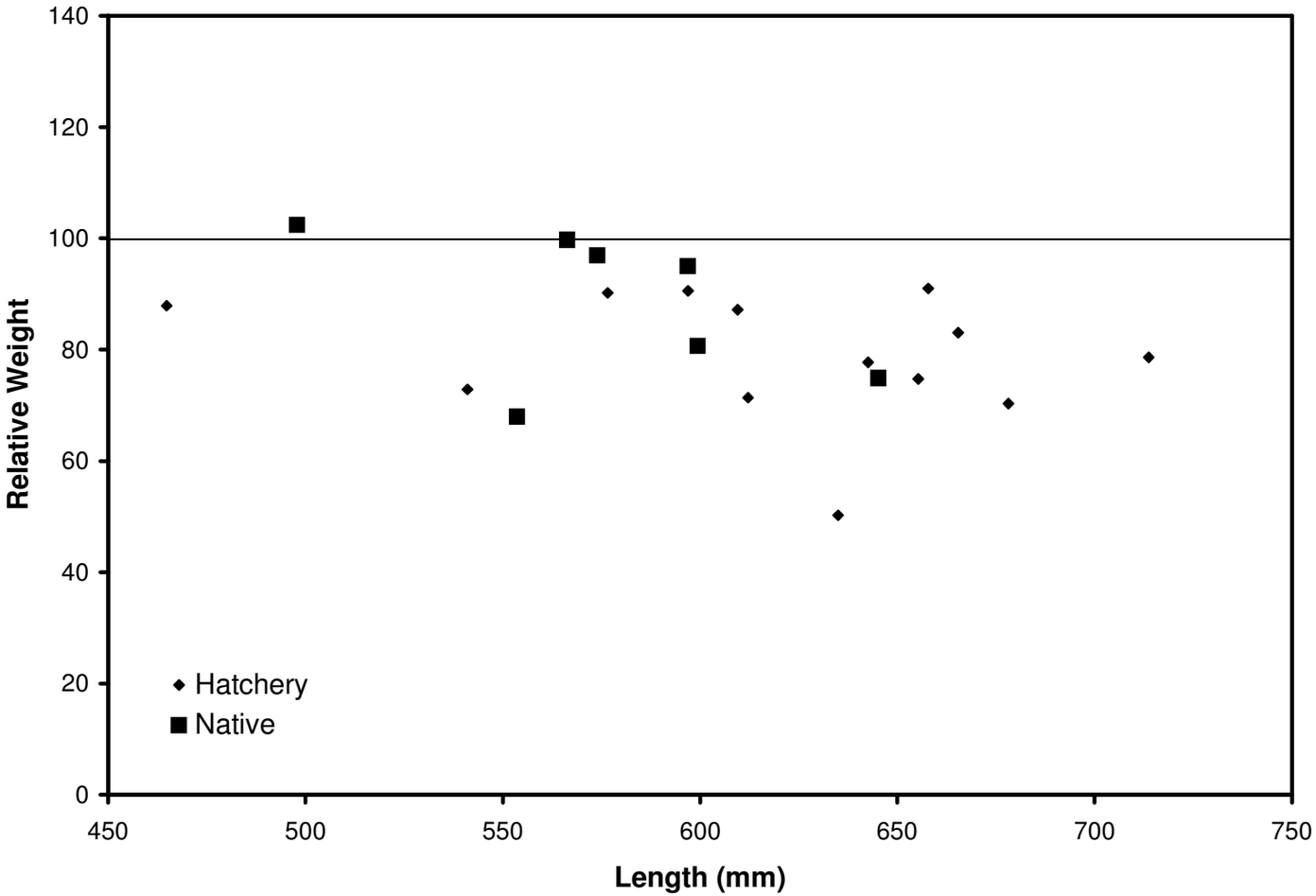

Figure 6. Relative weights of native and hatchery-reared lake trout captured in WI-1, 2003. A relative weight of 100 indicates the fish is at its expected weight.

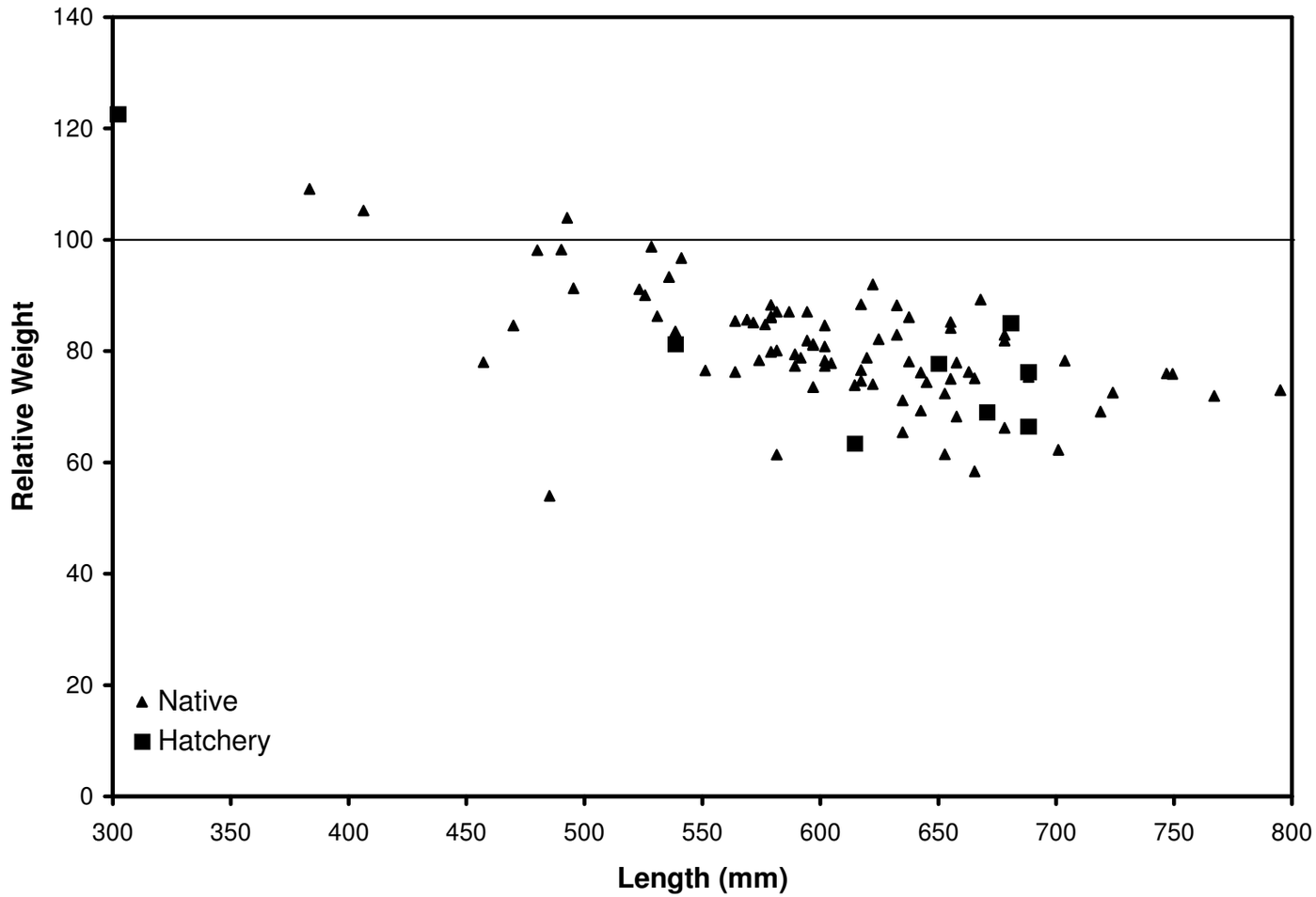

Figure 7. Relative weights of native and hatchery-reared lake trout captured in WI-2, 2003. A relative weight of 100 indicates the fish is at its expected weight.

2003 SPAWNING LAKE TROUT ASSESSMENT

METHODS

The standard index net on Gull Island Shoal (GIS) was 2,700 ft of 4-1/2-in and 6-in (stretch measure) monofilament mesh (6, 5-1/2, 6, 5-1/2, 6, 5-1/2, 6, 5-1/2,6). Each net was 300 feet long. The standard index gang was divided on Michigan Island Shoal (MIS): 1,500 ft (6, 5-1/2, 6, 5-1/2, 6) on Michigan Island, and 1,200 ft (6, 5-1/2, 6, 5-1/2) on Gull Island.

The standard index net on Sand Cut Reef (SCR) was 3,900 ft of monofilament mesh. Each net was 300 ft long and was arranged in the following sequence: 6, 5-1/2, 7, 4-1/2, 6-1/2, 5, 6, 5, 6-1/2, 4-1/2, 7, 5-1/2, 6. On SCR the gang was divided between the two humps: 1,800 ft on the west hump and 2,100 ft on the east hump.

All live fish were measured to the nearest tenth of an inch, sexed, tagged, inspected for lamprey marks, and released. Otoliths were removed from the dead, native fish.

Fish age was estimated by examining sectioned sagittal otolith planes.

STATUS OF SPAWNING STOCKS

GULL ISLAND SHOAL

In 2003, 1,252 spawning lake trout were sampled on GIS and 93% were native. Females constituted 18% of the sample. Lake trout catch-per-effort (CPE) for the 5-1/2-in the 6-in mesh both increased from 2002 to 2003 (Table 1). Spawning lake trout CPE has increased dramatically since 1961, when almost no females were caught during the spawning assessments (Figure 1). The increase of spawner CPE, however, appears to have leveled off since the early 1990s.

MICHIGAN ISLAND SHOAL

In 2003, 556 lake trout were sampled on MIS. Native fish constituted 96% of the catch and females comprised 26% of the catch. Lake trout CPE from the 5-1/2-in and 6-in mesh both increased from 2002 to 2003 (Table 1). Mean length of males and females was 27.6 in and 30.3 in, respectively.

GULL - MICHIGAN ISLAND COMPLEX

The GIS-MIS data for wild and hatchery-origin females were combined to monitor trends. Although variable between 1985 and 1995, the abundance of native females has increased gradually since 1964 (Figure 2). Lake trout CPE for all size intervals increased from 2002 to 2003 (Table 3).

Returns of previously tagged lake trout have allowed for annual estimation of the spawning population on Gull-Michigan Island Complex. Abundance of male lake trout was estimated using the Lincoln-Peterson population model with Bailey's modification. The number of females was then estimated using the sex ratio from the assessment catch.

Following is a breakdown of the 2003 GIS-MIS spawning population:

Native Males	15,673 $\pm$ 5774
Native Females	3732
Hatchery-origin Males	1032
Hatchery-origin Females	275
	20,712

Due to mesh size selectivity, small males recruiting into the spawning stock were not sampled. Spawning lake trout abundance increased from 2002 to 2003 (Table 2).

Egg deposition was estimated at 27.7 million eggs.

The average length of males and females was 27.8 in and 30.0 in, respectively. Long term trends in average size were not examined because the mesh size (size selectivity) of the gill nets has varied since 1965.

SAND CUT REEF

In 2003, 284 lake trout were sampled on SCR. Native fish comprised 93% of the catch. Catch-per-effort of spawners increased from 2002 to 2003 (Table 4).

2003 EGG HARVEST

Approximately 220,914 lake trout eggs and 209,654 splake eggs were collected by the Bayfield Fish Hatchery for the lake trout and splake stocking programs.

MEAN LENGTH-AT-AGE

The ages and lengths of 624 lake trout from sampling in 1999 through 2003 were grouped to estimate mean length-at-age. The mean age of male and female lake trout was 17.0 and 17.3, respectively. Mean length of males was usually lower than that of females at each age (Table 5).

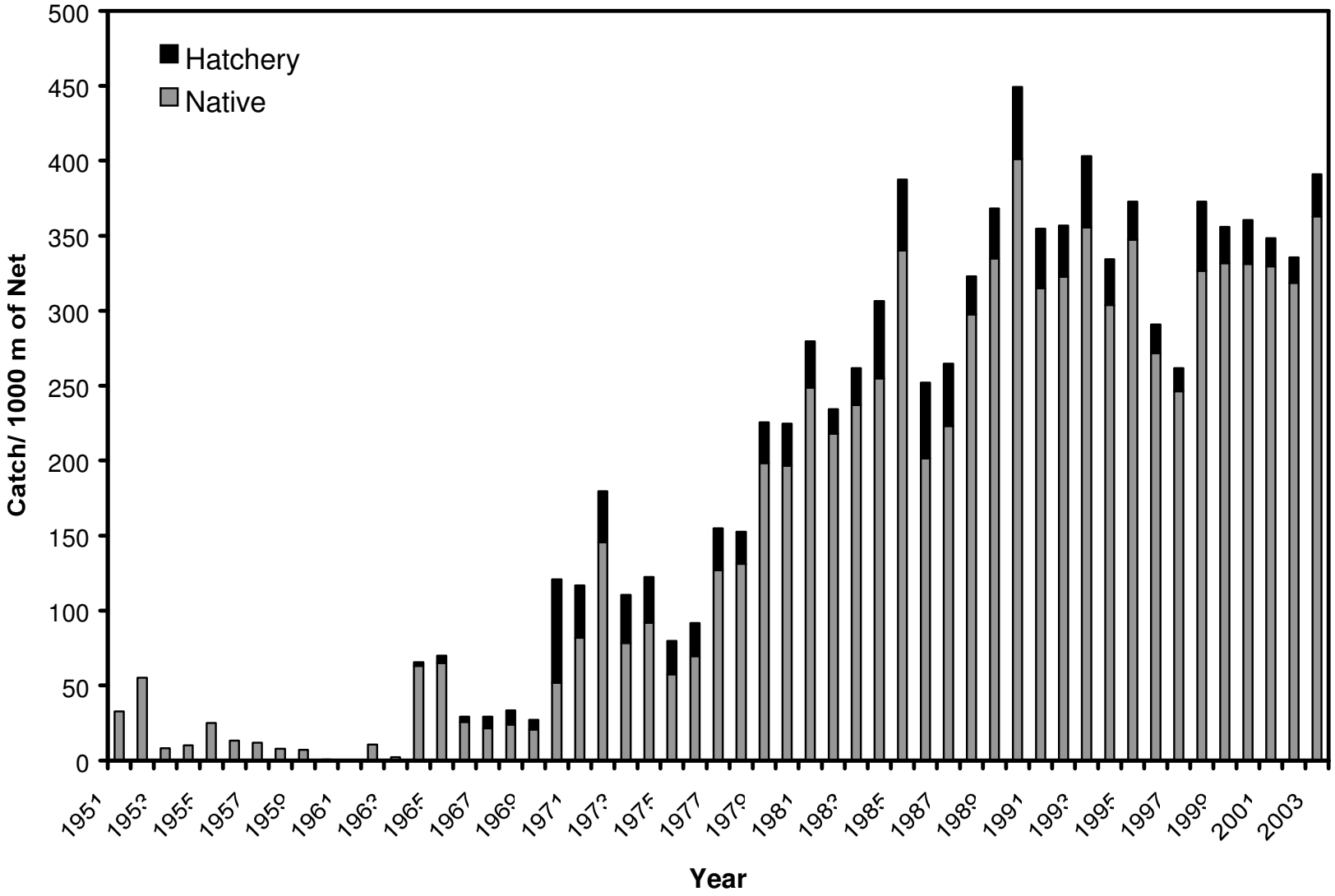

Figure 1. Lake trout catch per 1000 m of net from spawning assessments at only Gull Island Shoal, 1951-2003.

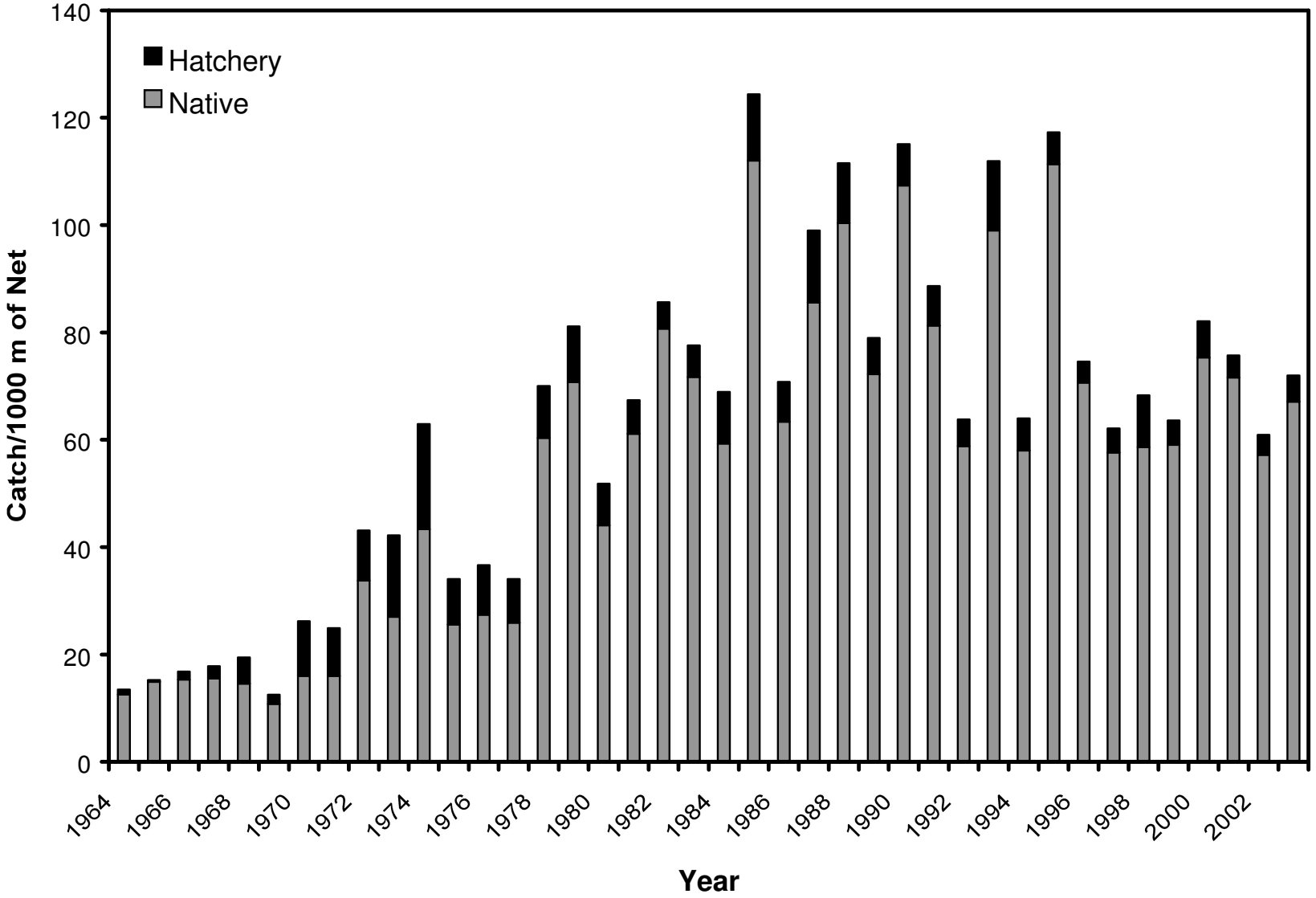

Figure 2. Female lake trout catch per 1000 m of net from spawning assessments at Gull Island Complex, 1964-2003.

Table 1. Lake trout catch per 1,000 feet of net (CPE) for 5-1/2-inch and 6-inch monofilament nets on Gull Island and Michigan Island Shoal, 1982-2003.

	Gull Island Shoal				Michigan Island Shoal			
Year	5-1/2" CPE	Ft. of Net	6" CPE	Ft. of Net	5-1/2" CPE	Ft. of Net	6" CPE	Ft. of Net
1982	136.7	3,000	68.9	5,400	143.3	1,200	87.9	2,400
1983	101.4	5,700	62.9	7,500	140.0	1,500	58.1	2,100
1984	125.0	4,500	74.4	8,100	135.5	2,700	75.9	6,300
1985	149.6	2,400	82.0	3,000	253.3	1,800	73.9	3,600
1986	97.7	4,800	73.2	6,000	174.2	2,400	103.0	3,000
1987	95.6	4,800	66.7	6,000	117.1	2,400	68.3	3,000
1988	115.4	4,800	82.5	6,000	137.5	2,400	94.3	3,000
1989	148.5	4,800	80.3	6,000	132.1	2,400	84.7	3,000
1990	173.3	2,400	104.0	3,000	187.5	2,400	105.7	3,000
1991	111.5	4,800	102.0	6,000	103.8	2,400	68.0	3,000
1992	119.8	4,800	96.8	6,000	98.3	2,400	89.3	3,000
1993	153.3	4,800	121.2	6,000	92.1	2,400	74.7	3,000
1994	116.9	4,800	87.0	6,000	95.0	2,400	58.7	3,000
1995	136.7	3,600	92.0	4,500	151.3	2,400	108.3	3,000
1996	101.3	4,800	77.0	6,000	94.2	1,200	73.3	1,500
1997	87.1	4,800	71.7	6,000	55.8	2,400	55.3	3,000
1998	122.7	4,800	99.8	6,000	110.4	2,400	82.0	3,000
1999	111.3	4,800	103.2	6,000	85.8	2,400	72.3	3,000
2000	117.7	4,800	100.8	6,000	76.3	2,400	58.3	3,000
2001	118.1	4,800	93.8	6,000	105.0	2,400	69.3	3,000
2002	113.1	4,800	91.2	6,000	72.9	2,400	60.3	3,000
2003	135.8	4800	100.0	6,000	112.9	2,400	95.0	3,000

Table 2. Estimates of the spawning lake trout population and egg deposition in the Gull Island Shoal Complex, 1965-2003.

Year	Native Males	Native Females	Hatchery Males	Hatchery Females	Total	Egg Deposition		
						Native	Hatchery	Total
1965	4,599	569		95	5,263			3,100,519
1970	1,302	355	1,754	407	3,818			2,420,024
1975	3,359	1,461	927	392	6,139	8,675,099	2,310,672	10,985,771
1980	12,103	2,689	1,174	528	16,494	16,290,873	3,180,021	19,470,894
1981	9,238	3,185	817	382	13,622	18,149,126	2,245,695	20,394,821
1982	7,032	2,930	778	219	10,959	15,872,354	1,199,857	17,072,211
1983	7,858	3,492	772	282	12,404	19,686,276	1,595,439	21,281,715
1984	11,241	3,122	1,752	536	16,651	17,834,933	2,978,308	20,813,241
1985	1,008	4,549	1,348	520	16,425	24,542,420	2,745,984	27,288,404
1986	10,892	3,513	2,118	460	16,983	18,101,064	2,657,644	20,758,708
1987	9,339	4,915	1,455	783	16,492	26,814,587	4,282,949	31,097,536
1988	9,800	4,261	818	451	15,330	21,427,460	2,274,264	23,701,724
1989	17,104	5,031	1,800	536	24,471	23,824,630	2,722,693	26,547,323
1990	11,877	4,399	1,188	338	17,802	22,491,955	1,764,604	24,256,559
1991	11,931	4,419	1,277	470	18,097	24,912,063	3,029,522	27,941,585
1992	13,184	3,216	1,271	268	17,939	18,809,289	1,648,746	20,458,035
1993	11,194	4,146	1,065	513	16,918	25,129,051	3,141,933	28,270,984
1994	14,564	4,551	1,099	382	20,596	25,853,462	2,346,080	28,199,542
1995	24,875	10,815	1,716	572	37,978	60,375,972	3,359,904	63,735,876
1996	11,362	4,058	834	254	16,508	24,067,246	1,615,708	25,682,954
1997	18,448	6,589	1,239	513	26,789	41,235,473	3,157,772	44,393,245
1998	11,937	2,776	1,486	461	16,660	18,098,010	3,305,949	21,403,959
1999	17,116	4,075	1,028	313	22,532	27,067,069	2,305,715	29,372,784
2000	17,060	5,882	1,147	532	24,621	38,420,244	3,795,136	42,215,380
2001	16,933	5,131	968	294	23,326	32,043,002	1,882,776	33,925,778
2002	15,502	3,164	564	204	16,270	20,500,671	1,266,120	21,766,791
2003	15,673	3,732	1032	275	20,712	25,542,254	2,199,461	27,741,715

Table 3. Lake trout catch per 1,000 feet of net (CPE) from 5-1/2-inch and 6-inch monofilament index nets on the Michigan-Gull Island complex, 1982-2003.

		21 - 24"		25 - 28"		29" - >	
Year	Effort (Feet)	No.	CPE	No.	CPE	No.	CPE
1982	12,000	63	5.3	721	60.1	380	31.7
1983	18,600	171	9.2	838	45.1	519	27.9
1984	18,000	242	13.4	898	49.9	417	23.2
1985	10,800	191	17.7	862	79.8	286	26.5
1986	16,200	199	12.3	1,035	63.9	308	19.0
1987	16,200	171	10.6	823	50.8	351	21.7
1988	16,200	228	14.1	1,139	70.3	294	18.1
1989	16,200	292	18.0	1,259	77.7	213	13.1
1990	10,800	201	18.6	1,047	96.9	247	22.9
1991	16,200	155	9.6	945	58.3	505	31.2
1992	16,200	206	12.7	948	58.5	506	31.2
1993	16,200	111	6.9	1090	67.3	707	43.6
1994	16,200	73	4.5	946	58.4	464	28.6
1995	13,500	118	8.7	1,034	76.6	441	32.7
1996	13,500	73	5.4	646	47.9	452	33.5
1997	16,200	88	5.4	542	33.4	518	31.9
1998	16,200	104	6.4	786	48.5	808	49.9
1999	16,200	219	13.5	724	44.7	632	39.0
2000	16,200	158	9.8	687	42.4	683	42.2
2001	16,200	182	11.2	790	48.8	619	38.2
2002	16,200	144	8.9	677	41.8	623	38.5
2003	16,200	175	10.8	916	56.5	716	44.2

Table 4. Catch per 1,000 feet of net (CPE), % female, native CPE, and % native of spawning lake trout at Sand Cut Reef, 1968-2003.

Year	Total CPE	% Female	Native CPE	% Native
1968	17.1	18.3	0.4	2.4
1969	18.7	12.3	1.8	9.6
1970	37.5	17.3	2.5	6.7
1971	23.3	16.3	5.7	24.6
1972	48.0	22.7	12.1	25.2
1973	19.9	26.6	5.7	28.6
1974	19.9	18.1	7.3	36.2
1975	17.5	17.6	8.0	45.7
1976	17.7	28.3	8.4	45.2
1977	26.0	10.8	11.6	44.6
1978	27.0	36.0	17.0	63.9
1979	43.9	25.5	25.2	57.4
1980	28.3	14.7	18.7	66.0
1981	22.8	22.1	12.9	56.6
1982	58.3	23.7	27.6	47.0
1983	12.2	26.7	8.1	66.7
1984	39.5	23.7	26.6	59.7
1985	41.5	25.9	22.6	54.3
1986	32.7	32.2	19.6	60.0
1987	13.8	46.3	10.5	75.9
1988	23.5	20.8	17.3	73.8
1989	46.2	14.2	35.9	77.8
1990	45.0	23.3	37.1	82.3
1991	25.8	30.8	21.9	85.1
1992	40.5	22.5	32.9	81.3
1993	34.1	16.5	25.9	75.9
1994	37.2	30.3	31.0	83.4
1995	38.2	16.5	31.0	81.2
1996	18.7	18.3	17.0	90.8
1997	30.0	19.7	25.0	83.3
1998	33.2	16.2	26.3	79.2
1999	47.1	15.0	42.1	89.4
2000	27.3	23.0	24.1	88.3
2001	52.1	18.2	47.2	90.6
2002	20.9	25.7	19.4	92.7
2003	36.4	26.4	33.8	92.9

Table 4. Mean length-at-age of lake trout sampled in 1999 through 2003. Lake trout that were aged from each year were combined to estimate mean lengths (in).

	Age	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	36	38	40
Males	Length	24.7	23.8	23.9	24.8	26.0	27.0	27.4	29.4	30.2	30.5	30.6	30.5	31.3	31.3	31.4	31.7	32.2	32.4	32.1	31.3	31.8	31.0	29.1	32.9	35.7	32.8	~	33.1	35.1	~
	N	4	3	13	25	26	27	19	29	25	27	42	26	14	21	19	23	17	7	8	9	3	2	1	4	2	4	~	1	1	~
Females	Length	~	25.8	27.2	25.3	25.9	28.1	29.3	31.0	31.4	31.7	33.0	31.9	32.0	33.4	32.5	33.8	33.5	33.8	~	35.2	34.0	33.8	~	33.3	33.6	~	33.2	~	~	33.8
	N	~	1	2	6	10	11	15	18	15	19	25	26	16	11	11	9	9	5	~	4	4	1	~	1	1	~	1	~	~	1

2003 SPAWNING LAKE HERRING ASSESSMENT

METHODS

Lake herring were sampled on December 3, 2003 during the spawning period at the established index station at Sand Island. Gill nets were set on the bottom for 24-hours. The standard index gang consisted of 1,200 feet of monofilament net. Each net was 300 feet long and arranged in the following sequence:

2-1/2" - 1-1/2" - 2" - 3"

A subsample of herring was measured to the nearest 0.1 inch and sexed. Ages were estimated for 99 herring using scales and otoliths.

RESULTS AND DISCUSSION

Lake herring catch-per-effort (CPE) increased from 2002 to 2003 (Table 1). The strong year classes in the late 1980's that dominated the spawning population are declining in abundance and are being replaced by the 1998 year class which constituted 64% of the sample in 2003 (Table 2).

Table 1. Lake herring spawning assessment catch data from Sand Island, 1980-2003. No data was collected in 1986 and 1987.

Year	Effort (Feet)	No. Fish	CPE/1,000'
1980	2,700	142	52.6
1981	2,700	394	145.9
1982	2,700	87	32.2
1983	2,700	162	60.0
1984	2,700	1,042	385.9
1985	2,700	156	57.7
1988	2,700	2,675	990.7
1989	1,500	1,482	988.0
1990	1,500	2,417	1,611.3
1991	1,500	1,350	900.0
1992	485	508	1,047.4
1993	1,500	1,294	862.7
1994	1,500	1,120	746.7
1995	1,500	1,586	1,057.3
1996	1,500	3,468	2,312.0
1997	1,500	3,173	2,115.3
1998	1,200	1,203	1,002.5
1999	1,200	755	629.2
2000	1,200	2,042	1,701.7
2001	1,200	2,133	1,777.5
2002	1,200	1,075	895.8
2003	1,200	1,654	1,378.3

Table 2. Length-at-age of spawning lake herring at Sand Island, 2003.

Age	4	5	6	11	12	13	14	15
Year Class	1999	1998	1997	1992	1991	1990	1989	1988
Number	13	63	3	1	4	8	5	2
% Frequency	13	64	3	1	4	8	5	2
Mean Length	10.8”	12.0"	13.4"	14.9”	15.0”	16.4”	16.3”	17.8”